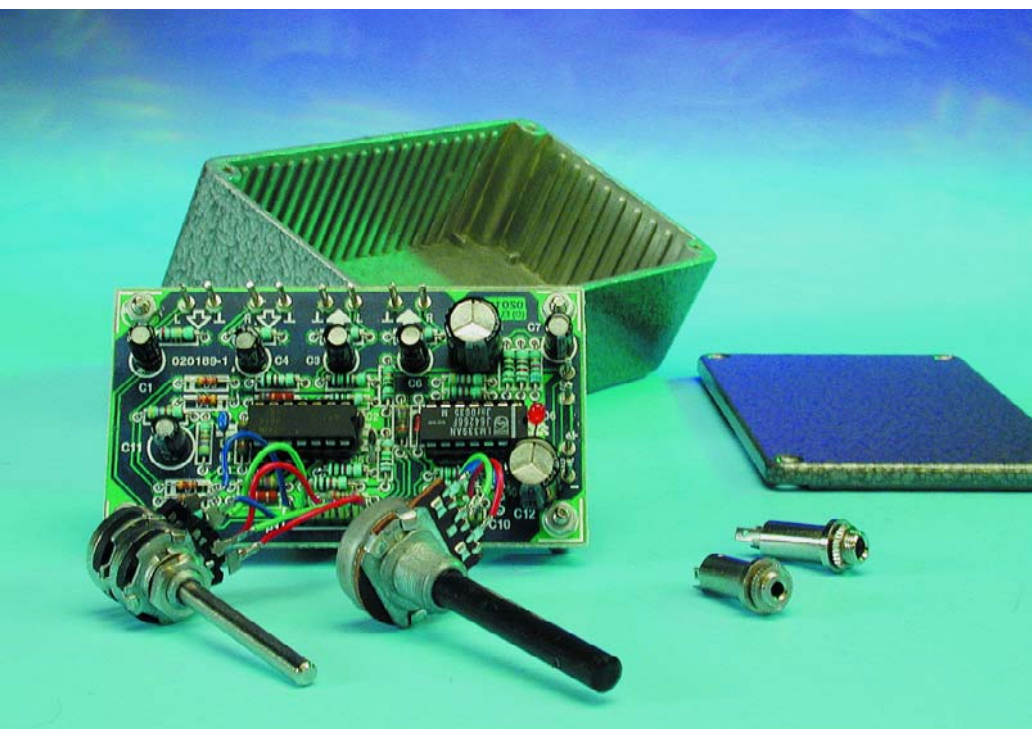


Audio Level Check for Line Input

for the PC sound card

Design by T. Giesberts

This simple control circuit allows the level of an external stereo audio source to be adapted to the sensitivity of, for example, a sound card. In addition, an LED indicates if any signal levels are present that can cause the input to be overdriven.



Standardisation is a long way off in many areas. This is certainly true for audio signal levels — a phenomenon that many of you will have encountered at one time or another, usually at the most inopportune moment. With equipment such as cassette decks, tuners, CD/DVD-players, one can never be quite sure

what signal level to expect. Anything is possible from around 200 mV to 2 V, or so.

If you wish to connect a signal source to an input that does not have a good input level adjustment, then this can easily lead to unpleasant sit-

uations. A PC sound card, for example, is generally not provided with a level control. In addition, the maximum allowable input voltage of such a card is limited by the 5-V power supply of the chipset. This limits the input to signals of less than 1 to 1.5 V, before clipping occurs.

The drawbacks that are caused in practice by such fixed input sensitivities and limited output signal levels can be mitigated by preceding the relevant line input with the control circuit that is described here. The signal levels of 2 V that modern CD- or DVD-players often provide can be reduced to an acceptable maximum. On the other hand, the output level of 200 mV that older equipment typically source, can be amplified, something that will improve the signal to noise ratio.

The adjustment range of our circuit amounts to no less than ± 20 dB, so every conceivable signal adaptation should be possible. In order to avoid being unpleasantly surprised by excessive signal levels, an LED indicator has been added which will indicate immediately when the output signal exceeds a certain (adjustable) value. Because the current consumption is a mere

few mA, the level adapter can simply be powered from a 9-V battery; that makes it pleasantly universally deployable.

Control circuit

If the circuit were only required to attenuate, then we could have made it easy for ourselves and a simple passive voltage divider would have sufficed. But in this case we also wanted to amplify and, in addition, we would also like a tidy circuit in which the input and output-impedance are not affected by the position of the potentiometers.

That is why we decided to go for a relatively 'mature' design. Each channel consists of an input buffer

and an adjustable amplifier stage. There is a single indicator common to both channels. In order to power the opamps symmetrically from a 9-V battery, a virtual ground point has been created with voltage divider R27/R28/C11. **Figure 1** shows the complete schematic.

The indicator will be described later, we will first take a look at the buffer and amplifier stage.

The function of the input buffers IC1c and IC1b is to provide a constant load for the attached signal source. The values are such that the input impedance is fixed at the well-known standard value of 47 kΩ. The opamps are connected as voltage followers, while resistors R3 and R12 bias them to half of the power supply

ply voltage. Because the circuit is powered from an asymmetric power supply, a coupling capacitor is present at the input. This capacitor is always charged by R1 and R10 to prevent any unwanted sound effects when the signal source is plugged in. The coupling capacitor is followed by an additional protection network, guarding against high peak voltages. This network consists of two diodes and a resistor.

For practical reasons, an inverting topology was purposely selected for the adjustable amplifier stages IC1a and IC1d. By using the inverting inputs, the load on the potential divider for the virtual ground (R27/R28) is smaller, allowing higher resistance values and consequently a lower total current consumption.

If, for the moment, we limit the description to the left channel only, we can establish that

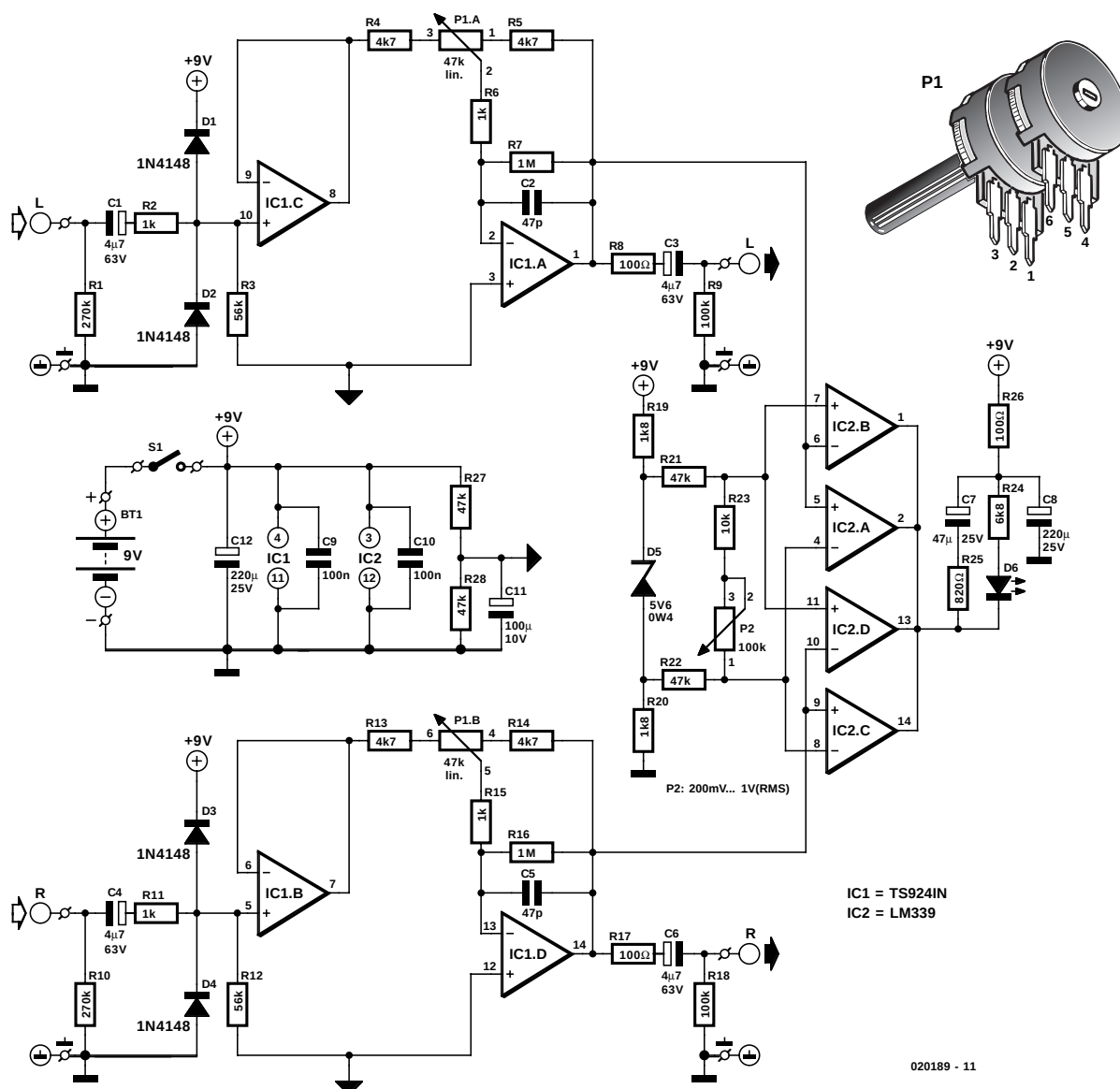


Figure 1. The level adapter actually consists of two separate circuits: the adjustment section and an overdrive indicator.

the maximum amplification of IC1a is equal to $(R5+P1)/R4$ and the minimum is equal to $R5/(P1+R4)$. Because of small losses elsewhere, this results in an adjustment range from 10.5 to 0.09, which pretty much corresponds to ± 20 dB.

Resistor R6 (R15) was added to prevent potential instability of the amplifier as a result of parasitic capacitance at the input of the opamp in case the wiring to P1 is a little bit long. Should the wiper of P1 be sporadically intermittent, R7 (R16) ensures that there is always negative feedback around the opamp and the output will always be nicely at half the power supply voltage. For stability reasons, C2 (C5) limits the bandwidth to 60 kHz at maximum amplification.

Another two components to complete the list: R8 (R17) ensures that the amplifier will be unconditionally stable even with a capacitive load at the output (because of long output cables, for example). R9 (R18) makes sure that the output electrolytic capacitor is always charged to prevent loud noises when the output load is plugged in.

It is worth mentioning that for IC1 we deliberately selected a rail-to-rail opamp, so that despite the low power supply voltage, reasonably high input voltages are still possible. The maximum is nominally more than $3 V_{RMS}$, while with a nearly exhausted battery $2 V_{RMS}$ is still not a problem.

Indicator

The overdrive indicator is built around quad comparator IC2. This IC is used to build a window comparator for each channel. The window comparator compares the output signal of the adjustable amplifier stage with a variable reference. The outputs of IC2 are of the open-collector type and can therefore be simply connected together. If one of the comparator input signals exceeds the reference voltage, adjusted with P2, LED D8 will light up.

A few additional details regarding this circuit. The reference is set symmetrically around half the power supply voltage with the aid of R19, D5 and R20, so that both the negative as well as the positive half of the signal voltage is monitored. Because the zener current is set to a really small value of only 1 mA, the voltage drop across D5 is only about 5.3 V. R21, R22, R23 and P2 are dimensioned such that the reference voltage, adjustable with P2, corresponds to signal voltages from 200 mV to $1 V_{RMS}$.

As can be seen in the schematic, LED D6 (and series resistor R24) is connected in parallel with an electrolytic capacitor (C7). This has been added to provide a certain amount of

afterglow so that short duration signal peaks will become better visible. R25 limits the maximum charging current of C7 to a safe value for IC2. Finally, R26 and C8 decouple the power supply so that any potential noise from the switching of the LED

has the least possible impact on the amplifiers.

Construction

An extremely compact circuit board has been designed for this circuit,

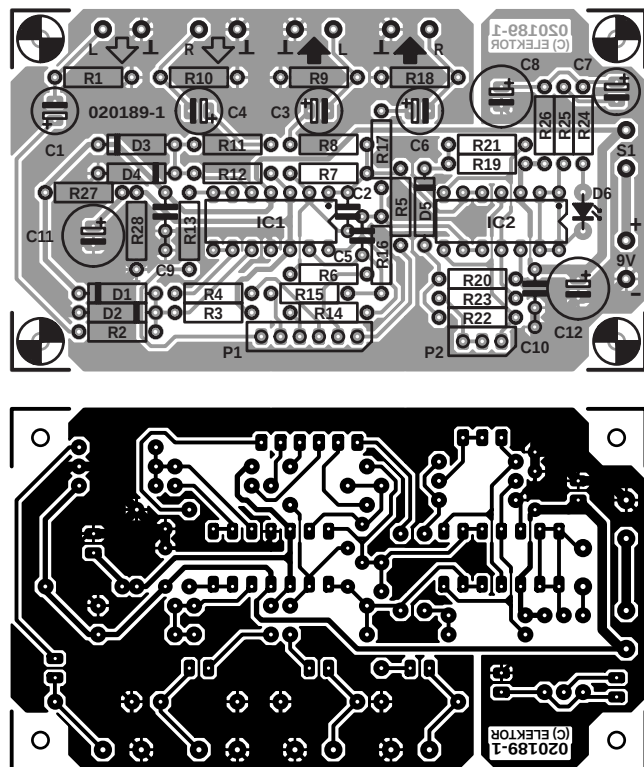


Figure 2. The dimensions of the PCB make an extremely compact construction of the level adapter possible.

COMPONENTS LIST

Resistors:

R1, R10 = 270k Ω
 R2, R6, R11, R15 = 1k Ω
 R3, R12 = 56k Ω
 R4, R5, R13, R14 = 4k Ω
 R7, R16 = 1M Ω
 R8, R17, R26 = 100 Ω
 R9, R18 = 100k Ω
 R19, R20 = 1k Ω
 R21, R22, R27, R28 = 47k Ω
 R23 = 10k Ω
 R24 = 6k Ω
 R25 = 820 Ω
 P1 = 47k Ω stereo potentiometer, linear
 P2 = 100 k mono potentiometer, linear

Capacitors:

C1, C3, C4, C6 = 4 μ F 7 63V radial
 C2, C5 = 47pF

C7 = 47 μ F 25V radial
 C8, C12 = 220 μ F 25V radial
 C9, C10 = 100nF
 C11 = 100 μ F 10V radial

Semiconductors:

D1-D4 = 1N4148
 D5 = zener diode 5.6V, 0.4W
 D6 = LED, red, high-efficiency
 IC1 = TS924IN ST (Farnell)
 IC2 = LM339

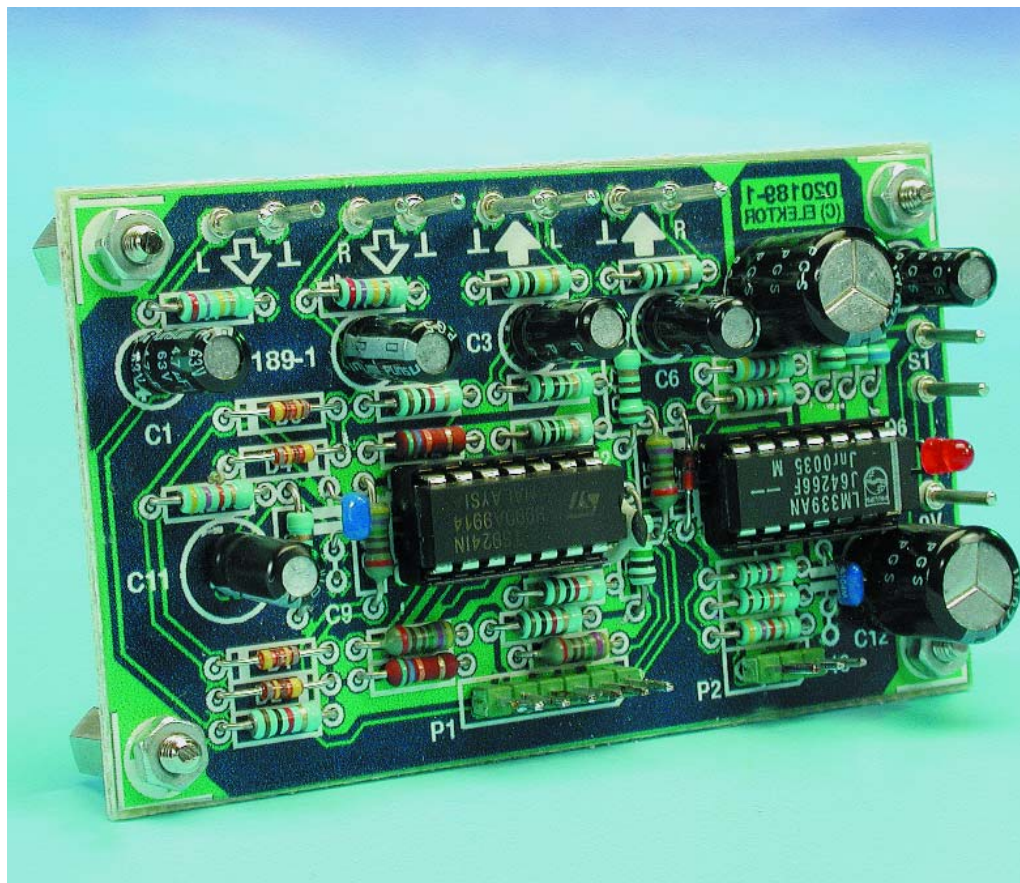
Miscellaneous:

S1 = rocker switch, 1 make contact, for chassis mounting
 BT1 = 9 V battery with holder
 Two 3.5 mm stereo jack sockets, chassis mount
 PCB, order code **020189-1** (see Readers Service page). PCB layout file also available from Free Downloads at www.elektor-electronics.co.uk

the layout and component overlay of which is shown in **Figure 2**. To make sure that the adjustment and indicator parts of the circuit don't 'bite' each other, there is a deliberate separation between the grounds of both sub-circuits. The circuit board is quite densely populated with parts, so construction should not be hurried.

The terminals for the inputs and outputs are nicely grouped on one side of the PCB, while on the opposite side two SIL headers can be found for the connections to P1 and P2. These components have deliberately not been fitted directly on the PCB so that everyone can determine for themselves what type of input and output connectors (e.g. mini-jack, cinch) and potentiometers to use. In addition, this also affords greater freedom in the selection of a suitable enclosure.

The wiring between the input and output connectors needs to be done with shielded cable. Standard hook-up wire can be used for the potentiometers, but with the chan-



Some measurement results

Input impedance		47 k Ω
Input voltage max.	(THD = 0.1%)	3.2 V _{RMS}
Output voltage max.	(THD = 0.1%)	3.1 V _{RMS}
THD+N (B=80 kHz)	200 mV in, 20 mV out	0.027 % (20 Hz - 20 kHz)
	200 mV in, 200 mV out	0.005 % (20 Hz - 20 kHz)
	200 mV in, 2 V out	0.002 % (20 Hz - 1 kHz)
		0.028 % (20 kHz)
THD+N (B=80 kHz)	2 V in, 200 mV out	0.0026 % (20 Hz - 1 kHz)
		0.007 % (20 kHz)
	2 V in, 2 V out	0.002 % (20 Hz - 1 kHz)
		0.01 % (20 kHz)
Channel separation		> 66 dB (1 kHz)
		> 42 dB (20 kHz)
Current consumption	LED off	6.7 mA
	LED on	7.8 mA

nel separation in mind, it is best to keep the wiring to P1 as short as is possible. It is also recommended to use a potentiometer with a metal housing for this, the case of which is connected to ground with a short wire. Make sure that when wiring P1

and P2 that they are connected in such a way that the level increases when they are turned clockwise. The numbers of the connections shown on the schematic correspond with those of the SIL headers on the PCB. Once the circuit has been built into

an enclosure, both potentiometers can be provided with a scale to indicate the amplification and indicator signal level respectively.

The enclosure is preferably made from metal, because this minimises possible disturbances from any potential external noise sources. The metal of the enclosure needs to be connected to ground of the circuit. For example, a suitable enclosure is type Box1590N1 from the company H.O.D. However, the space inside this enclosure is just a little too small to fit the battery as well — in this case the next larger size will have to be used. For completeness' sake, we will mention that it was naturally the intention that D6 is mounted in such a way that it is visible from the outside.

As already mentioned, the current consumption of the circuit is so low (about 7 mA) that a power supply consisting of a 9-V battery can suffice. However, if you will be using the circuit in a more permanent application than a mains adapter is certainly more appropriate. A good adapter with regulated output is preferred. It is particularly important that the no-load voltage of the adapter does not exceed 12 V, because that is the maximum operating voltage of IC1.

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